

**MULTIMEDIA**



**UNIVERSITY**

**STUDENT ID NO**

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# MULTIMEDIA UNIVERSITY

## FINAL EXAMINATION

**TRIMESTER 2, 2017/2018**

**TCS3511 THEORY OF COMPUTING/  
TIC2151 THEORY OF COMPUTATION/**

**( All sections / Groups )**

**7<sup>th</sup> MARCH 2018  
9:00–11:00AM  
(2 Hours)**

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### INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 4 pages only excluding the cover page.
2. Attempt All questions. All questions carry equal marks and the distribution of the marks for each question is given.
2. Please write your answers in the answer booklet provided. Please write the question number of each answer clearly.

**QUESTION (1)****NOTE: Attempt any THREE out of FOUR Parts (A), (B), (C) and (D).**

(A)

- 1) What is *Theory of computation*? (Give a precise definition) [2 marks]
- 2) Prove the following by construction: [3 marks]

"For any integers  $a$  and  $b$ , if  $a$  or  $b$  is even, then  $ab$  is even".

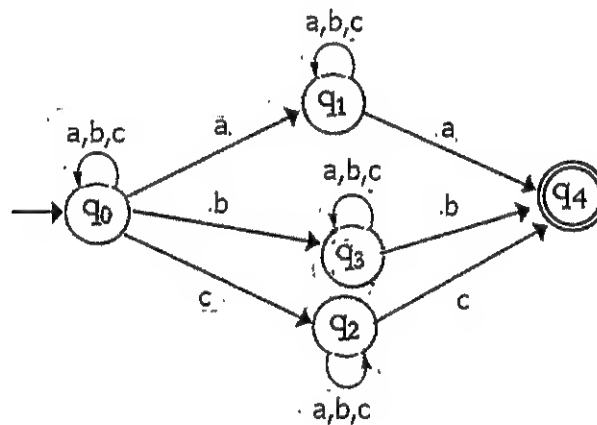
B) Draw state diagrams for DFAs accepting each of the following languages:

$L_1 = \{w \in \{a, b\}^* \mid w \text{ is the set of strings that start with } aba \text{ or } bab\}$  [2.5 marks]

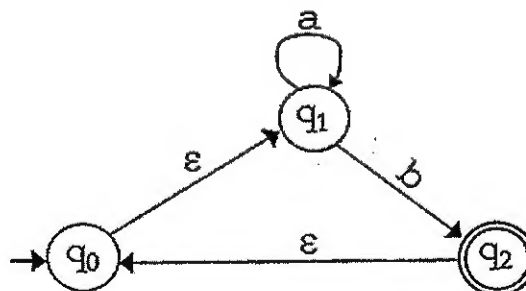
$L_2 = \{w \in \{a, b\}^* \mid w = a^{n+1}b^m, n, m > 0\}$  [2.5 marks]

(C)

- 1) What is the language recognized by the following NFA? (Give a precise description) [2 marks]

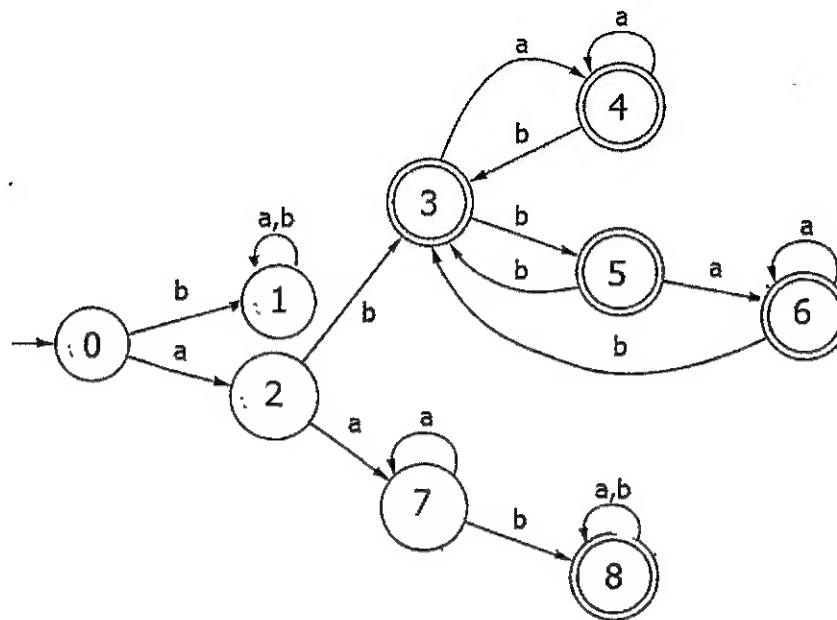


- 2) Convert the following NFA into an NFA without  $\epsilon$ -transition. Show the new table of transition and the corresponding state diagram.. [3 marks]



(D) Minimize the following DFA. Show your steps.

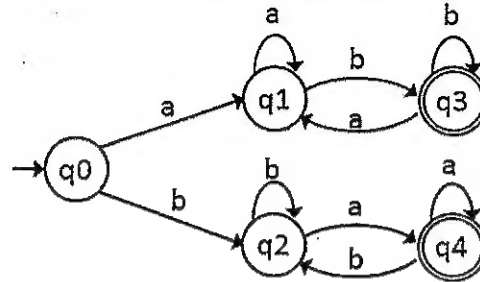
[5 marks]



**QUESTION (2)**

(A)

- 1) Determine the regular expression corresponding to the following automaton.



[1 mark]

- 2) Determine the language corresponding to the following regular expression.

$$a(a + b)^+ b$$

[1 mark]

- 3) Find a regular expression corresponding to each of the following languages.

[3 marks]

- $L = \{ w \in \{0, 1\}^* \mid \text{the length of } w \text{ is at most } 4 \}$
- $L = \{ w \in \{0, 1\}^* \mid \text{String } w \text{ begins and ends with } 00 \text{ or } 11 \}$
- $L = \{ w \in \{0, 1\}^* \mid \text{Strings } w \text{ that do not end with } 01 \}$

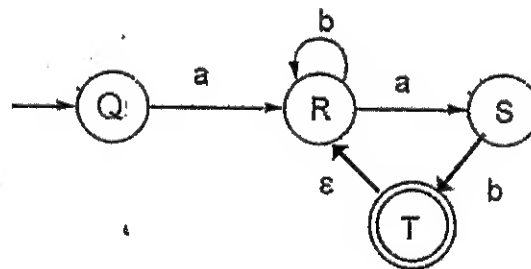
- (B) Convert the following regular expression into an NFA. Follow the construction rules closely and do not just give a simpler NFA even though it is possible.

[5 marks]

$$((0 + 1)(0 + 1)^*)^2$$

(C)

- 1) What is the regular grammar corresponding to the NFA given below? [2 marks]



- 2) Give the regular grammars corresponding to following languages over the alphabet  $\{0, 1\}$ .

$$L_1 = \{ w \mid w \text{ contains at least two } 0\text{'s or two } 1\text{'s} \}$$

[1.5 marks]

$$L_2 = 00(10)^+11$$

[1.5 marks]

**QUESTION (3)**

- (A) Construct a PDA over the alphabet  $\{a, b\}$  for each of the following languages:

$$L_1 = \{a^n b^{2n+2} \mid n \geq 0\} \quad [2.5 \text{ marks}]$$

$$L_2 = \{a^n b^n c^{m+1} \mid n, m \geq 1\} \quad [2.5 \text{ marks}]$$

- (B) Convert the following context-free grammar into Chomsky Normal Form (CNF). Show your main steps. [5 marks]

$$S \Rightarrow aXbX$$

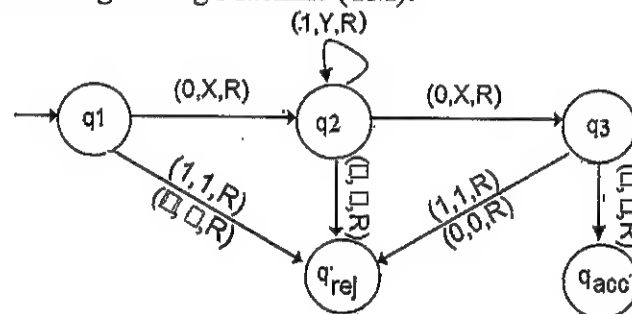
$$X \Rightarrow aY \mid bY \mid \varepsilon$$

$$Y \Rightarrow X \mid c$$

**QUESTION (4)**

**NOTE: Attempt any TWO out of THREE Parts (A), (B) and (C).**

- (A) Given the following Turing Machine (TM):



- 1) What language does the following Turing Machine accept? Give the language in RE form. [1.5 marks]
  - 2) Give the formal definition of this Turing Machine including the transition table. [3.5 marks]
- (B) Construct a Turing Machine for the language  $L = \{a^n b^n \mid n \geq 1\}$ . [5 marks]
- (C)

- 1) What does it mean to say that a set  $S$  is countable? Explain briefly. [2 marks]
- 2) A language  $L$  is TM-decidable if there exists a TM  $M$  that can decide it.

Consider the language:

$$A_{TM} = \{ \langle M, w \rangle \mid M \text{ is a TM and } M \text{ accepts the input } w \}$$

Proof by contradiction that the language  $A_{TM}$  is not TM decidable. [3 marks]

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